

CLAIMS

1. A fuel injection control method for controlling a fuel injection characteristic of a pressure boosting common rail fuel injection apparatus, the pressure boosting common rail fuel injection apparatus including a fuel injection valve which directly injects fuel into a combustion chamber of an internal combustion engine; a common rail which stores fuel having a predetermined pressure and supplies the fuel to the fuel injection valve; and pressure boosting means for increasing the pressure of the fuel supplied to the fuel injection valve from the common rail to a predetermined boosted pressure that is higher than the predetermined pressure of the fuel in the common rail, and the pressure boosting common rail fuel injection apparatus performing boosted pressure fuel injection by operating the pressure boosting means so as to increase a fuel injection pressure of the fuel injection valve when necessary, the fuel injection control method characterized by comprising the steps of:

deciding a fuel injection amount that is an amount of fuel to be injected from the fuel injection valve according to an engine operating state when the boosted pressure fuel injection is performed; and

deciding a pressure boosting period that is defined as a time interval from when operation of the pressure boosting means is started until when the fuel injection is started, based on a relationship that is defined in advance using the decided fuel injection amount and an engine rotational speed.

2. The fuel injection control method according to claim 1, characterized in that when the boosted fuel injection is performed, the pressure of the fuel in the common rail is controlled to a constant base rail pressure irrespective of the engine operating state, fuel injection starting timing is decided based on a relationship that is defined in advance using the fuel injection amount and the engine rotational speed, and operation starting timing of the pressure boosting means at which operation of the pressure boosting means is started is decided based on the decided fuel injection starting timing and the pressure

boosting period.

3. The fuel injection control method according to claim 2, characterized in that the pressure boosting period is set to a negative value in a case where the fuel injection is started before the operation of the pressure boosting means is started, and the pressure boosting period is set to a positive value in a case where the fuel injection is started after the operation of the pressure boosting means is started.

4. The fuel injection control method according to claim 3, characterized in that a relationship between the operation starting timing of the pressure boosting means and the fuel injection timing is set according to the engine operating state such that

(1) in a case where the engine is operated at an intermediate load, the fuel injection is started before the operation of the pressure boosting means is started, and the fuel injection is ended after the operation of the pressure boosting means is started, and before the pressure of the fuel supplied from the common rail to the fuel injection valve reaches the boosted pressure;

(2) in a case where the engine is operated at a load lower than the intermediate load, the fuel injection is ended before the operation of the pressure boosting means is started;

(3) in a case where the engine is operated in a vicinity of a maximum torque point, the fuel injection is started after the operation of the pressure boosting means is started, and before the pressure of the fuel supplied from the common rail to the fuel injection valve reaches the boosted pressure, and the fuel injection is ended after the pressure of the fuel reaches the boosted pressure; and

(4) in a case where the engine is operated in a vicinity of a maximum output point, the fuel injection is started after the operation of the pressure boosting means is started, and after the pressure of the fuel supplied from the common rail to the fuel injection valve reaches the boosted pressure.

5. The fuel injection control method according to any one of claims 2 to 4, characterized in that the pressure boosting means is prohibited from being operated in a case where the fuel injection is ended before the operation of the pressure boosting means is started.

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6. The fuel injection control method according to any one of claims 2 to 4, characterized in that switching is performed between the boosted fuel injection and normal pressure fuel injection that is performed with the pressure boosting means being in a non-operated state; the base rail pressure is set to a value equal to a lowest fuel injection pressure during the boosted pressure fuel injection; and in a case where the fuel injection pressure lower than the base rail pressure is required when the normal pressure fuel injection is performed, the pressure of the fuel in the common rail is set to a value lower than the base rail pressure by opening a pressure reducing valve provided in the common rail.

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7. The fuel injection control method according to any one of claims 2 to 4, characterized in that switching is performed between the boosted fuel injection and normal pressure fuel injection that is performed with the pressure boosting means is in a non-operated state; the base rail pressure is set to a value equal to a lowest fuel injection pressure during the boosted pressure fuel injection; and in a case where the fuel injection pressure lower than the base rail pressure is required when the normal pressure fuel injection is performed, the pressure of the fuel in the common rail is set to a value lower than the base rail pressure by controlling a discharge flow rate of a high pressure fuel injection pump which supplies the fuel to the common rail.

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8. The fuel injection control method according to claim 6 or 7, characterized in that the boosted pressure fuel injection is performed in a first engine operating region in which the engine is operated at a high load; the normal pressure fuel injection is performed with the fuel injection pressure being set to the value lower than the base rail

pressure in a second engine operating region in which the engine is operated at a load lower than the high load; and an engine operating region is provided in the first engine operating region in a vicinity of a boundary between the first engine operating region and the second engine operating region, and in the engine operating region, the fuel injection
5 is performed with the pressure of the fuel in the common rail being set to a value equal to the base rail pressure, and with the pressure boosting means being in the non-operated state.

9. The fuel injection control method according to claim 2, characterized in that
10 when the boosted pressure fuel injection is performed, a valve opening period of the fuel injection valve is decided based on a relationship that is defined in advance using the pressure boosting period and the fuel injection amount.

10. The fuel injection control method according to any one of claims 6 to 8,
15 characterized in that when the boosted pressure fuel injection is performed, a valve opening period of the fuel injection valve is decided based on a relationship that is predefined in advance using the pressure boosting period and the fuel injection amount; and when the normal pressure fuel injection is performed, the valve opening period of the fuel injection valve is decided based on the pressure of the fuel in the common rail and
20 the fuel injection amount.

11. The fuel injection control method according to claim 2, characterized in that
when the boosted pressure fuel injection is performed, the operation of the pressure
boosting means is stopped simultaneously with an end of the fuel injection from the fuel
25 injection valve.

12. The fuel injection control method according to claim 2, characterized in that
when the boosted pressure fuel injection is performed, the operation of the pressure
boosting means is stopped before an end of the fuel injection from the fuel injection

valve.

13. A fuel injection apparatus characterized by comprising:

5 a fuel injection valve which directly injects fuel into a combustion chamber of
an internal combustion engine;

a common rail which stores fuel having a predetermined pressure and supplies
the fuel to the fuel injection valve;

10 a pressure boosting device which increases the pressure of the fuel supplied to
the fuel injection valve from the common rail to a predetermined boosted pressure that is
higher than the predetermined pressure of the fuel in the common rail; and

15 a controller which decides a fuel injection amount that is an amount of fuel to
be injected from the fuel injection valve according to an engine operating state when
boosted pressure fuel injection is performed with the pressure boosting device being
operated so as to increase a fuel injection pressure of the fuel injection valve, and which
decides a pressure boosting period that is defined as a time interval from when operation
of the pressure boosting device is started until when the fuel injection is started, based on
the decided fuel injection amount and an engine rotational speed.